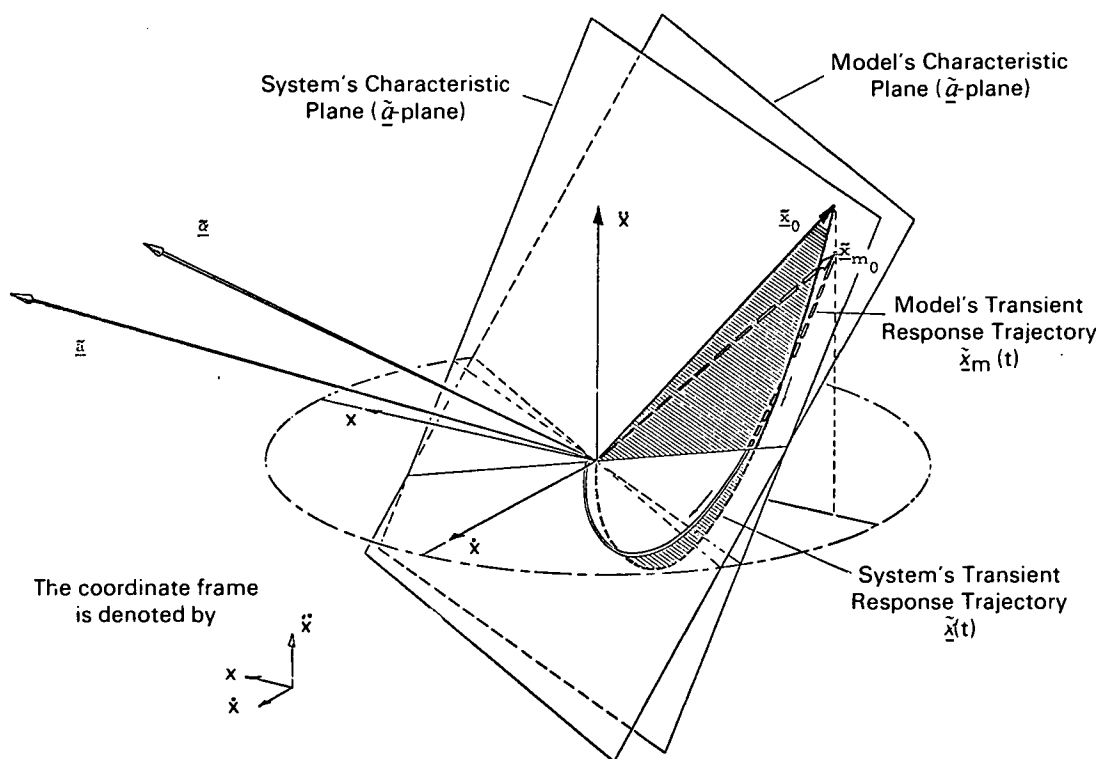


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New Model Performance Index for Engineering Design of Control Systems



Geometric Representation of Approximation of One Dynamic System by Another

The problem:

Development of an analytical design technique, for flight-control systems, to replace the lengthy and laborious conventional linear servo-theory techniques.

The solution:

A new Model Performance Index (Model PI) is applicable to linear flight-control systems. It is used

to bridge the gap between engineering specifications and the purely mathematical optimization process; also it provides a new interpretation of quadratic cost functionals, used in optimal control theory, that offers a physical basis for selection of the state-vector weighting matrix.

Flight-control systems are linear over only a limited range of amplitude at best. In the preliminary stage of design it is usually quite adequate to treat

(continued overleaf)

them as linear systems unless the dominant characteristic is a nonlinear element. Here only linear or linearized control-system design is considered, as well as only time-invariant, deterministic systems—or ones that can be satisfactorily represented as such. However, most of the preliminary effort in design of flight-control systems falls within the restricted class of design problems treated.

How it's done:

A performance index is developed that includes a model to represent the design specifications in a manner entirely different from that of the familiar model-referenced integral squared-error performance index. It is based on a geometric criterion for approximation of one dynamic system (the model) by another (the actual system) (see figure). The basic form of the resultant Model PI is the same as that of quadratic functionals frequently appearing in modern control theory. The important point, however, is the ability to interpret the performance index directly in terms of a model of the desired system response without actually having the model's time response in the performance index.

The technique is adapted for use of a computer. A change of input-data cards for each new design, and a single subroutine-rewrite, enable the computer-processed analytical design program to switch from one problem in design to another.

Notes:

1. The technique may interest designers of flight-control or other physical-control systems.
2. Requests for further information may be directed to:

Technology Utilization Officer
Headquarters
National Aeronautics
and Space Administration
Washington, D.C. 20546
Reference: TSP 70-10293

Patent status:

No patent action is contemplated by NASA.

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